CHARACTERIZATION AND MEMS APPLICATIONS OF NANOTHERMITE MATERIALS

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ABSTRACT

The research described herein is on characterization of nanothermite materials and development of nanothermite microdevices for shock wave generation, microthruster propulsion, and intracellular particle delivery and cell transfection. The research progressed from basic nanothermite combustion characterization to application specific testing of microchip devices.

The nanothermite powders were initially characterized in a shock-tube system to demonstrate the production of shock waves. Then a microchip platform was developed to ignite the nanothermite on-chip. The microchips containing nanothermite were then characterized in a shock-tube to compare the shock waves produced in the microchip with those produced by nanothermite powders. The microchips were then modified for safe application to bio-systems. Transfection is demonstrated in primary cells, a cancer cell line, and in whole tissues. The ability to control the level of particle delivery is also demonstrated. Finally, the nanothermites are characterized in a microthruster for comparison of performance with other microthruster fuels.

The nanothermites showed generation of high-velocity (up to Mach 3) but low-intensity (shock waves <1MPa), which are appealing for certain applications. The on-chip igniters were capable of igniting nanothermite with very low energy (<100μJ). The devices for cell transfection showed superior transfection rate and cell survival compared with other transfection methods. The nanothermite also showed superior performance in generating high-amplitude short-duration thrust impulses compared with conventional energetic materials used in microthrusters.